Successful Methods

A Magazine of Construction Service

Published by SUCCESSFUL METHODS, Inc.

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141 Centre St., New York City, N. Y.

Vol. 7 — AUGUST, 1925 — No. 8

One a Minute

AMERICAN manufacturers are justly proud of their production records. Our vast home markets provide an outlet that permits most lines of industry to take full advantage of quantity production. Records of a thousand a day or a million a day, depending on whether it is automobiles or chewing gum, are commonplace. But the record on which we can always count is that there is a fool born every minute. Certainly in no line of industry does this hold so true as in road contracting.

When we first began to build improved highways on a vast scale in this country ten to fifteen years ago, there was much to learn about costs. The specifications for road surfacing then began to change so fast that it was hard for a contractor to accumulate any cost experience he could use later. Tightening up on inspection also had its effect. Rapidly changing prices of materials and labor brought further uncertainties. For the last two or three years, however, conditions that affect road building have been fairly stable in this country. In fact, in some states they have been probably more favorable than in many other lines of industry.

In spite of this stabilizing of conditions, we continue to see some of the wildest bidding imaginable by road contractors. High and low bidders will vary frequently as much as 50 per cent on big jobs. The extremes are usually about as bad one way as the other. But it is the wild low bid which messes up everybody concerned.

State highway officials have no choice. If the low bidder can qualify, he gets the job. The state official feels he is out from under because he can fall back on the bonding company. And it would astound the public to know the percentage of road jobs that are finished by the bonding companies in some states. Accurate figures are not available, but in one state it appears that nearly half the road contracts let in the last four years have been finished by the bonding company.

Highway officials may contend that the public does not lose when the contractor on a road job goes broke, providing his bond is good. No expert in economics is necessary to prove the fallacy of this contention. The delay in reorganizing the job means weeks or months of a partially blocked road. This is only one factor in the situation.

There seems to be no way in which to reduce the production of fool bidders. The only hope might be to surround him in such manner as to keep him from butting out his brains. Society is progressing in the protection of unfortunates generally. Our highway organization system, however, allows the wild low bidder to run amuck while he ruins himself and damages a lot of other folks.

Truly, there is one a minute produced. But is it the irresponsible low bidder or the public official that deserves the title?

Looking Them Over

WE recently sat on the steps of a construction mess house with the superintendent at about 6.30 a. m. From the time of our arrival, the previous afternoon, there had been almost continuous talk of methods of moving dirt. That morning at breakfast, by lamplight the discussion waxed warm over certain fine points. After the men went for the teams and trucks, the talk overflowed to the steps. To all appearances, the superintendent was submerged in putting over his arguments on methods.

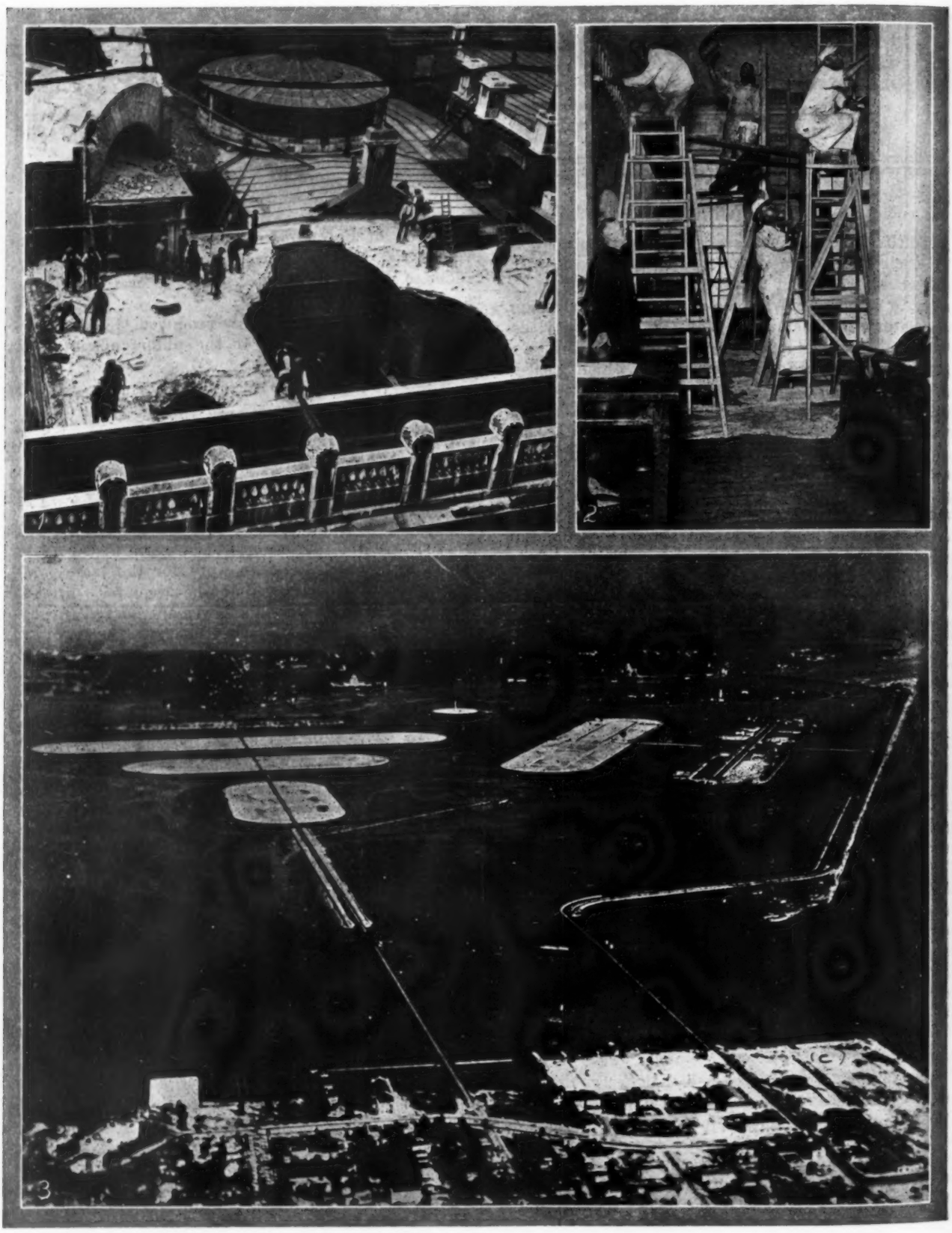
About this time the mule teams began to pass. The superintendent never misfired once in his talk, but his eye was on those mules. Suddenly he called one of the boys out of line and sent him to the blacksmith to have a mule's shoes tightened. Then he spotted a trace chain wired together. That boy went to the harness tent for a new chain. And so it went. Not a weak spot got by the superintendent's experienced eye. Later, we learned that this superintendent usually finished breakfast ahead of the crew and was at the stables when the harnessing was under way. Nothing missed him there. The small fixing-up jobs were all done before the teams started.

The same close inspection came that night. Not a team missed the superintendent's careful once-over. As a matter of course, the shoulders of each mule are washed with dilute oak-bark water. Once a week all collars are thoroughly washed. There are few sore shoulders in that outfit.

This idea of close check on every detail we found went right through the job. The shovel runner of the outfit is a born superintendent himself. So he could be trusted to look out for his own upkeep. But on every other part of the job, the superintendent personally checked the details every day.

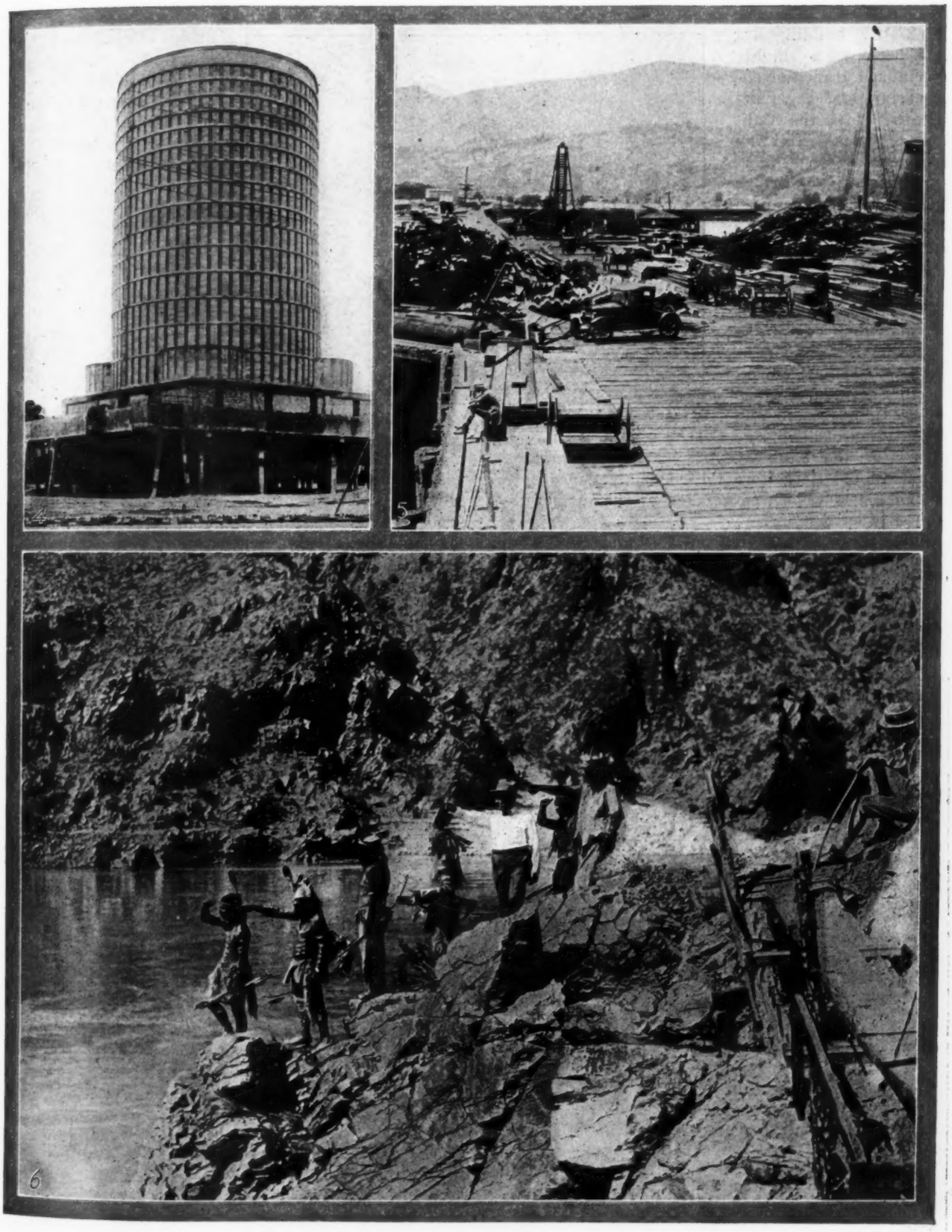
What is the answer? This outfit has made cost and speed records in moving dirt which it would be unfair to print. They have made them, too, without any fuss or feather, largely by keeping fixed the little defects which slow up the whole job.

Old and New Jobs



1. Even the Bank of England has to put itself in the hands of constructors. This photograph shows workmen engaged in removing the roof preparatory to reconstruction. © *International*
2. While President Coolidge is at Swampscott, the painters are busy in his offices at the White House. © *P & A*
3. The real estate boom in Florida is being helped along by the creation of artificial islands at Miami. Several of these islands in Biscayne Bay are shown in this photograph taken from an airplane. © *P & A*

Keep Builders Busy



4. The cooling tower of the great electric light plant recently built in Berlin, Germany. © *International*
5. Within a day or two after the earthquake ships were unloading supplies of lumber for reconstruction at the Santa Barbara docks. © *P & A*
6. Zuni Indian chiefs joined Governor J. G. Scrugham of Nevada on the inspection trip of the site of the Great Boulder Dam. © *International*

CALIFORNIA BUILDS MODERN BRIDGES

Highway Commission Is Responsible for Many New and Up-to-Date Structures

BRIDGE building has become a highly specialized branch of engineering and recognizing this fact the California State Highway Engineer has gathered together in the Bridge Department a trained corps of bridge engineers and has placed in their hands all of the bridge work of the Highway Commission. As a result of this policy the Bridge Department now handles the supervision of all bridge construction as well as the design and preparation of all bridge plans for the Highway Commission. Heretofore the superintendence of the bridge construction was handled by the various division engineers.

TYPICAL GRADE SEPARATION—AN UNDERPASS NEAR REDDING, SHASTA COUNTY

After about a year's trial of this system of having the bridge construction as well as the design of the bridges under the supervision of the Bridge Engineer it seems to be a very satisfactory method of handling this particular class of work.

In addition to handling the state bridge work, the Bridge Department has prepared plans for bridges for the counties, checked numerous county designs and also designs prepared by the United States Bureau of Public Roads, for bridges to be constructed on the State highway.

The Bridge Department also has charge of the elimination of railroad grade crossings on the State highways. With the great increase in automobile traffic this problem has become a very serious and important one. In 1923 the records show that approximately 10 per cent of the number of persons killed in automobile accidents met death at railroad grade crossings. The number apparently is increasing annually. During the last two years eight railroad grade crossings have been eliminated and plans are now under way for the elimination of twenty-two others.

The cost of the elimination of the most dangerous grade crossings now existing on the California high-

HAULING REINFORCING STEEL FOR WHITEWATER RIVER BRIDGE

UPSTREAM SIDE OF WHITEWATER RIVER BRIDGE

way system has been estimated at about $17,000,000.

Typical structures completed during the last two years and some of the larger projects now under construction by the Highway Commission are briefly described herewith.

A bridge 248 ft. in length, consisting of one 100-ft. two-rib reinforced concrete open spandrel arch and a series of 15-ft. approach spans, was built over the Susan River near Devil's Corral. This structure is located near the Southern Pacific bridge over the river and, by altering the west approach to the latter, a grade separation was effected. This provided a beautiful structure over the river and at the same time eliminated a dangerous railroad grade crossing.

A similar structure was constructed under the Southern Pacific Railroad, near Cottonwood, in Shasta County.

A bridge consisting of two 34 ft. and one 39 ft. reinforced concrete girder spans over the tracks of the San Francisco-Sacramento Railroad near Denverton has eliminated a dangerous railroad grade crossing.

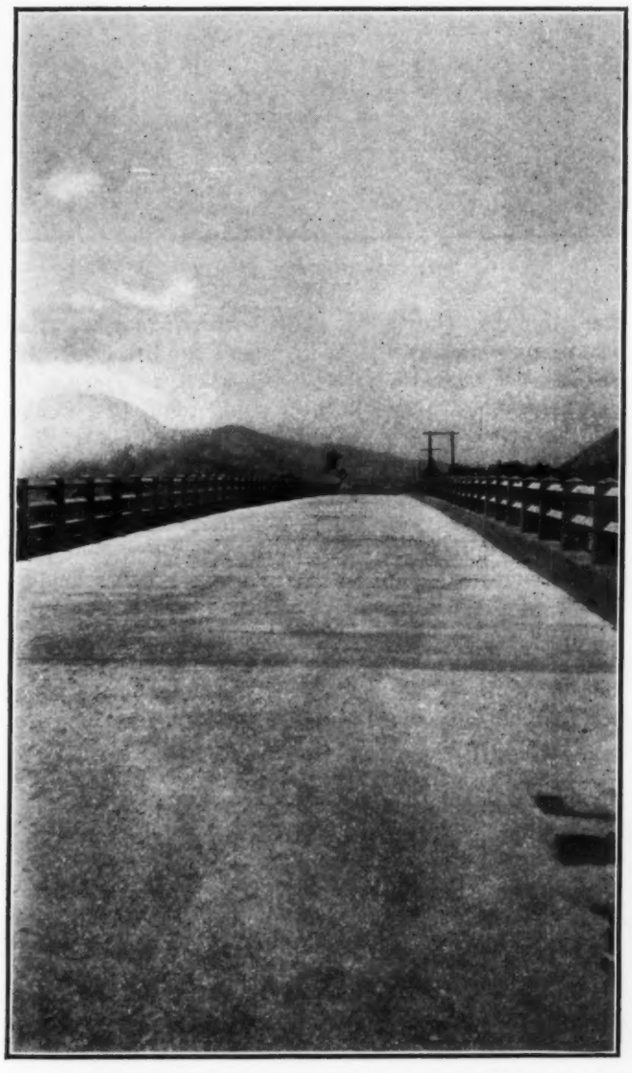
The Cuyama River bridge is 356 ft. in length, consisting of one 200-ft. steel truss span with concrete floor and five 30-ft. reinforced concrete girder approaches, spans the Cuyama River about 14 miles east of Santa Maria.

A bridge 734 ft. in length, consisting of three 163-ft. reinforced concrete arch spans and eight 30-ft. concrete girder spans on pile bents, is being constructed across the Van Duzen River near Alton, in Humbilt County, on the Redwood highway.

A bridge 608 ft. in length, consisting of twenty reinforced concrete girder spans on concrete bents over Crystal Springs Dam, 3½ miles west of San Mateo on the Skyline Boulevard between San Francisco and Glenwood, has a clear width of roadway of 30 ft. suitable for caring for the heavy traffic on this road and replaces an old timber trestle.

A bridge 432 ft. in length, consisting of eight 54-ft. reinforced concrete girder spans on concrete piers and abutments with a clear roadway width of 21 ft., was built over the Whitewater River near Whitewater, in Riverside County.

The channel width was contracted by constructing protection dykes which direct the water through an opening about one-half the size of that which otherwise would have been required. The length of bridge



PAVEMENT ON WHITEWATER RIVER BRIDGE

CURVED BRIDGE ACROSS PACHECO CREEK—IT HAS A SUPERELEVATION OF 2 FT.

was thereby shortened considerably, and a great saving of cost was effected. Flood conditions in this locality are such that it was necessary to carry piers and abutments to considerable depth to prevent undermining by scour.

A memorial bridge to be known as the G. H. Douglas Bridge is being constructed across the Klamath River three miles above its mouth on the Redwood highway between Eureka and Crescent City. This structure, which will be one of the finest bridges in the country, will consist of five reinforced concrete arches on pile foundations, together with two 50-ft. approach spans. The five arches will each be 210 ft. in length. The total length of the bridge will be 1147 ft. The total cost will approximate $400,000, of which sum $225,000 was appropriated by the legislature and the balance derived from State highway funds. The structure will replace an antiquated ferry system which has long hampered the development of the northwestern part of the State, and is much needed.

A type of construction known as the sidehill viaduct has been used in the mountainous region on the Redwood highway, where the rocky hillside is on such a steep slope that the removal of vast quantities of material would otherwise be required to construct a road. The structure is in form a horizontal shelf tied to the rocky hillside and supported at its outer edge by vertical concrete posts. The structure is constructed of reinforced concrete. Great economy has been effected by employing this type of construction, which it is now proposed to use extensively in other portions of the State.

One of the most unusual bridges is a new structure across the south fork of Pacheco Creek on the Pacheco Pass State highway, Santa Clara County. This bridge has a superelevation of two feet and is built on a 170-ft. radius curve, and is 218 ft. in length. It is shown in the photograph on this page.

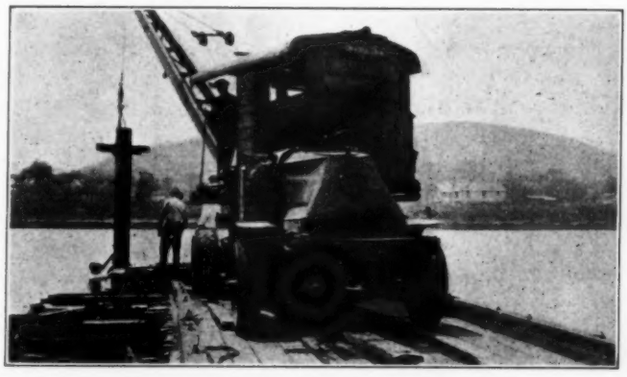
CONNECTICUT FURNISHES PICTURE ON COVER

THE photograph on the cover of this issue of SUCCESSFUL METHODS shows the Rings End Road at Darien, Fairfield County, Conn. It is a splendid example of the type of concrete road that makes New England so popular with motorists. Connecticut, although a small State, has been a leader in the building of good roads for many years. And it not only builds them, but maintains them as well.

CRANE FINDS PLENTY OF WORK

Handles Timber and Helps to Drive Steel Piling in Midstream

IN order to improve its water system the city of Binghamton, N. Y., recently decided to replace an old crib in the Susquehanna River with a modern structure of greater capacity. The contract for destroying the old crib and building a new one was awarded to A. W. Bowie, engineer and general contractor of Binghamton.



TAPPING STEEL PILING INTO PLACE

One of the units of Mr. Bowie's construction plant was a crane mounted on a motor truck and although the job is not yet completed, he has found this crane almost invaluable in handling various details of the work. It first proved its usefulness in building the timber bridge which had to be constructed from the river bank to the crib offshore. The crane handled the timber for this structure, and because of the comparative lightness of the crane, it was not necessary to build as substantial a causeway as would ordinarily be the case as the crane and motor truck weigh only 22,000 lb.

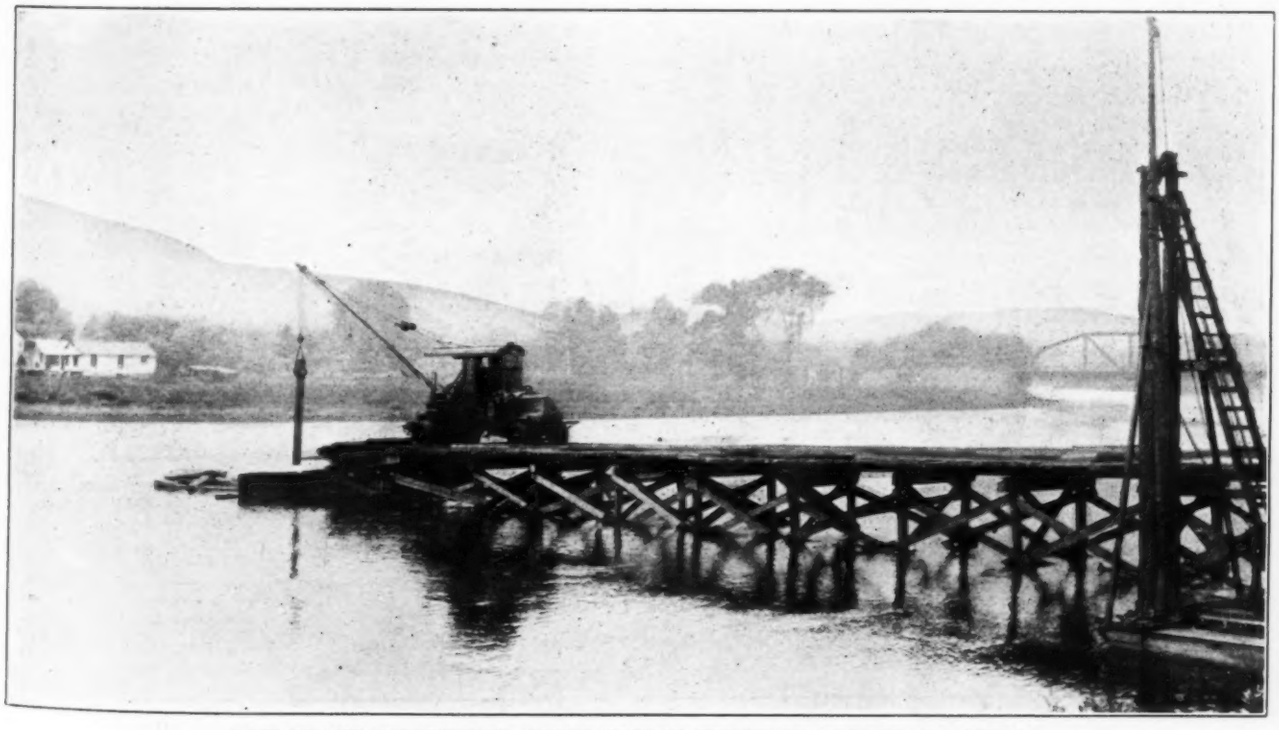
The old crib was destroyed by blasting and the crane equipped with a clamshell bucket removed the blasted material. In driving the steel piling for the cofferdam, the preparation for building the new concrete crib, the crane also was utilized. It was equipped with a steam hammer and did a good share of the work. It would have been sufficient for the whole job but for the fact that the steel encountered hard material which the steam hammer was not heavy enough to penetrate.

The photographs which accompany this article were taken on a day when the crane was tamping the steel piling. As may be seen in these photographs a large timber was utilized for this purpose and the crane handled it in satisfactory fashion.

The mobility of the crane and its adaptability to various sorts of work make it an exceedingly useful tool on this kind of a job. It is not necessary to keep the crane on the job every minute and at times when it is not needed, it can be sent out to other parts of the city for temporary work, such as unloading freight cars, digging small excavations, etc.

This particular crane has been employed in general service work in and about the city of Binghamton and is operated by Mr. Bowie under the name of the Crane Service Company, Inc. It recently traveled from Binghamton to Buffalo and back, a round trip of more than 400 miles.

The versatility of a machine is an important factor in its value to its owner.



THE CRANE WORKING ON LIGHT BRIDGE WHICH IT HELPED TO BUILD

LOCOMOTIVES LIFT BRIDGE

Raise Steel Railway Span 23 Feet to Allow Big Dredge Room Enough to Crawl Under. No Interference with Train Service

TIMBER towers 44 ft. in height placed on the piers at either end of a steel railroad bridge made it possible to lift the bridge high enough to allow a big dredge to pass safely under it. For weeks the dredge had been idle because its path was effectually blocked by the Chicago & Eastern Illinois Railroad bridge over Busseron Creek, near Sullivan, Indiana. This steel bridge, a 105-ft. span, was built in 1892 and has a total weight of approximately 100 tons.

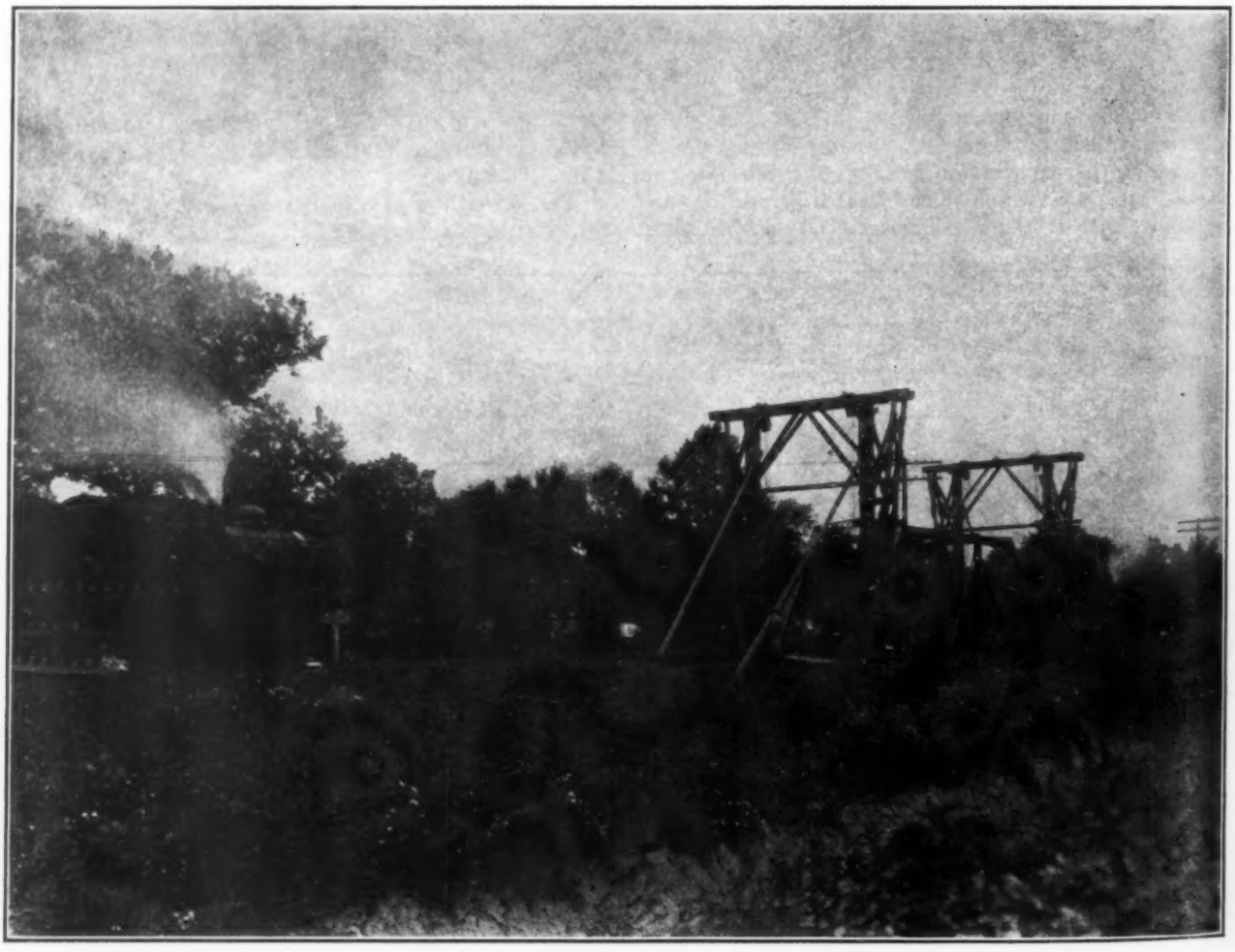
The railroad company obtained an injunction restraining the dredging contractor from interfering with the operation of the bridge and it was expected that this temporary injunction would be dissolved Monday noon, July 20. For this reason the railroad company made arrangements to move the bridge and the work was done in the following manner:

The timber towers were placed on the piers at either end of the bridge and outside of the trusses. These bents were constructed of 12 in. by 12 in. timbers and were of a total height of 44 ft. from the top of the pier to the top of the bent. They were erected with a locomotive crane between trains so as not to interfere with traffic. The bents were then rigged with 6 sheave blocks carried on a 6-in. car axle at the top and a six-sheave block to which was fastened a yoke around the end pins of the bridge.

The blocks were then reeved with 13 parts of $\frac{5}{8}$ in. diameter steel cable and the lead end of the wire was fastened to a locomotive at either end of the bridge. The locomotives were then signaled and went ahead at the same speed, and the bridge was slowly raised a height of 23 ft. 6 in. in order to clear the dredge, which then deepened the channel sufficiently to allow it to pass under the bridge.

The bridge was then lowered without a mishap, the track was connected, and traffic was resumed.

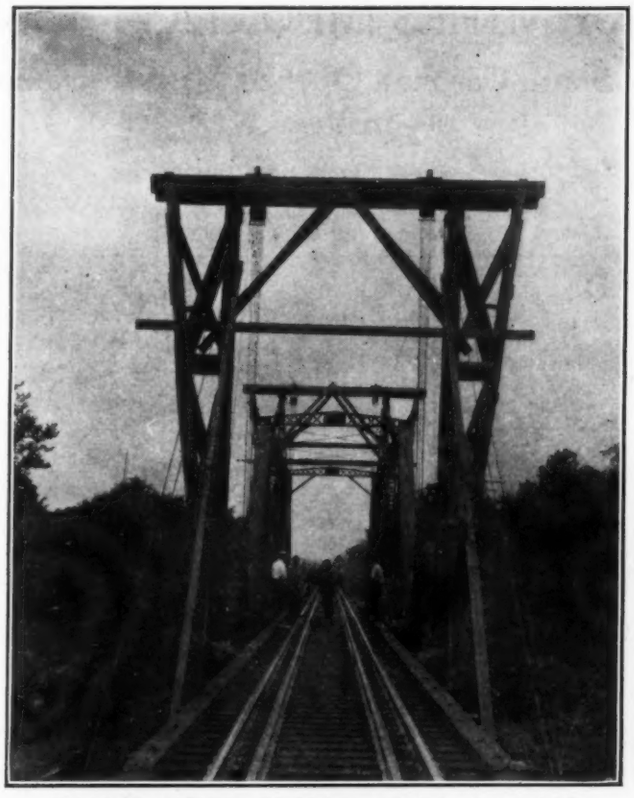
The work of actually raising the bridge to the maximum height took only four minutes and it was lowered in just half a minute longer. The dredge men had figured that it would take them an hour to dig their way through, but it really took them nearly three hours.



THE TWO LOCOMOTIVES AT EITHER END OF BRIDGE BEGINNING TO RAISE STEEL SPAN

In order to provide against any emergency or accident, duplicate train orders were issued to reroute all trains after the hour of raising the bridge, but it was found that it was not necessary to detour any train. The contract was completed within the five working days specified. The work was done under a penalty clause of $1,000 per day for each day after noon Monday, July 20, at which time it was believed that the injunction would be dissolved.

The three photographs which accompany this article clearly show various phases of the job. The photograph at the bottom of page 8 was taken just as the two locomotives began to raise the bridge. It required extremely careful handling of the two big engines to keep them moving in unison so that the bridge would be raised evenly.



WOODEN TOWERS IN PLACE READY FOR WORK

The small photograph on this page was taken looking through the bridge with the towers, pulleys and cables in place.

The large photograph at the bottom of this page shows the bridge high in the air with the dredge at work under it. It may be seen that the bridge was lifted high enough to allow the dredge a considerable margin of safety in making its way underneath. The bridge gang is enjoying a rest while the dredge is at work.

The bridge was raised by the Kelly-Atkinson Construction Co., Chicago. J. H. Bernhardt, Engineer of Bridges, was in charge.

BRIDGE RAISED 23 FT. ABOVE ITS USUAL LEVEL WITH DREDGE AT WORK DEEPENING STREAM UNDERNEATH

GEORGIA FINISHES IMPORTANT HIGHWAY

Connecting Link with South Carolina Opened Despite Damage by Flood Early in Year

By FRED. M. GARNETT
State Highway Department of Georgia

GEORGIA and South Carolina have just completed what is known as Federal Aid project No. 286 located in Chatham County, Georgia, and Jasper County, South Carolina. This project begins about 8.5 miles from Savannah near the village of Port Wentworth and crosses the Savannah River and marsh into South Carolina, ending at a point 7 miles from Hardeeville.

The bridges span the Front River, the Middle River and the Little Back River. This project was opened on July 27 and only remarkable work by the Georgia Highway Department made it possible to finish the road at this time. It will be remembered that this spring Georgia was visited by unprecedented floods which worked havoc with this particular stretch of highway. This article describes some of the effects of the floods and the extra work, new plans and increased expense which they made necessary.

COMPLETED BRIDGE BEFORE ASPHALT SURFACE WAS LAID

This project was approved by the Federal Government for construction at a cost of $692,466.26, and is being constructed jointly by the states of Georgia and South Carolina. Before work was begun it was certified that funds were to be provided for the construction of this project as follows:

EMBANKMENT JUST BEFORE WATER ROSE AND COVERED IT

DIKES MADE TO PROTECT EMBANKMENT BY PLOWING FURROW DOWN ROAD AND THROWING MATERIAL ON UPSTREAM SIDE

Federal Aid of Georgia	$173,000
Federal Aid of South Carolina	150,000
Savannah River Bridge Commission of S. C.	150,000
Chatham County, Georgia	200,000
Total	$673,000

It was believed that the marginal difference of $19,466.26 would not be required, as it was not anticipated that any contingencies in excess of this amount would be needed; however, the recent freshet was so disastrous as to necessitate the securing of additional funds.

The high water of this year established levels of from 2.0 ft. to 3.0 ft. higher than those of the Harrison Freshet of 1841, which up until January 1925 was recognized as the worst freshet in the history of the state. As a result of the extraordinary amount of rainfall, especially at the watersheds of the principal streams, the larger rivers began to rise rapidly, and soon overflowed their banks before adequate protection could be provided the highways and structures. Consequently much damage was done that could not be avoided, due to the lack of time in which to meet the exigencies of the occasion. The damage done to Georgia's highways and bridges was considerable, but an accurate estimate as to cost is not available as yet.

The grading work as called for in contract required 243,633 cu. yds. embankment above marsh, and had a contract value of $158,361. The grading work had been completed, and was being surfaced when the freshet occurred, which washed away approximately 20,000 cu. yd. of material. There were six washouts in the embankment, despite the fact that every effort was made to avert this damage. An effort was made to save the embankment by plowing a furrow along the roadway, and throwing up a dike on the upstream side; this procedure was successful, and helped save the embankment in many places that were threatened. The slopes of the embankment were also thoroughly sand-bagged, and the abutments to the bridges were rip-rapped. With these precautions taken, little damage would have occurred had it not been for the breaking of a freshet bank, or dike, located 1.5 miles above the project near Vanezobre Creek. This dike was approximately 2.5 miles long, and had withstood all freshets up until the eventful freshet of last January. As a result of this freshet bank breaking, the impounded water came with such force against the embankment on the project that it was broken in six places.

The bridge work on this project originally called for five bridges, and had a contract value of $313,667.17. The lengths of these bridges as called for on the plans are as follows: Bridge No. 1, 1466 ft.; bridge No. 2, 1815 ft.; bridge No. 3, 1988 ft.; bridge No. 4, 200 ft.; and bridge No. 5, 200 ft., making a total of 5669 ft. of opening. Also a new bridge known as Bridge No. 6 had to be built; this bridge is 400 ft. in length, and was constructed where a washout of this length happened which washed away 6540 cu. yds. of material. In the construction of this bridge at this point, the embankment did not have to be replaced; moreover, it was advantageously located with respect to the probable future overflow of the old freshet bank.

A peculiar damage was done to Bridge No. 4 by the

BREAK IN EMBANKMENT AT BRIDGE NO. 4. THE FLOOD MADE IT NECESSARY TO INCREASE LENGTH OF THIS BRIDGE BY 200 FT.

action of the water which scoured out the piling to two of the decks, resulting in the collapse of same. This bridge is located across an old canal on a skew. The class of material through which the piling was driven was coarse river sand, and a blue, marlaceous substance. At least 12 ft. penetration was obtained in driving the piling; despite this fact, the water cut 13 ft. below the bed of the canal, as was afterwards determined by soundings. A collection of drift wood on the upstream side was thought to have given the water an eddying effect which resulted in completely uprooting the piling to the two decks which collapsed.

Without any immediate funds available to repair the damages done by the freshet, some steps had to be taken to provide for this unforeseen contingency. In this connection a meeting was held in the Commissioner's Office of Chatham County, Savannah, Georgia, February 13, 1925, for formulating a plan for financing the repair work. There were officials present from the Georgia and South Carolina State Highway Departments, the Savannah River Bridge Commission of South Carolina, and Chatham County, Georgia. An agreement was entered into, and work was prosecuted as rapidly as possible.

A contract was let March 3, 1925, for constructing the new 400 ft. bridge, and increasing the length of bridge No. 4 200 ft. The approximate quantities are as follows: 620 cu. yd. Class "A" concrete, 104,800 lb. reinforcing steel, 2300 lin. ft. 14 in. by 14 in. precast piles, 450 lin. ft. 16 in. by 16 in. precast piles, 1200 lin. ft. concrete railing, 270 sq. yd. rip rap.

The total length of the project is 24,375 ft., or 4.62 miles. The earthwork grading on this project had a contract value of $158,361. After the embankment was brought to grade it was protected from hard rains and freshets by placing muck soil on the shoulders and slopes, and planting grass afterwards. The cost of protecting the embankment in this manner was only $7,151.34 and proved to be of untold value during the record breaking freshet.

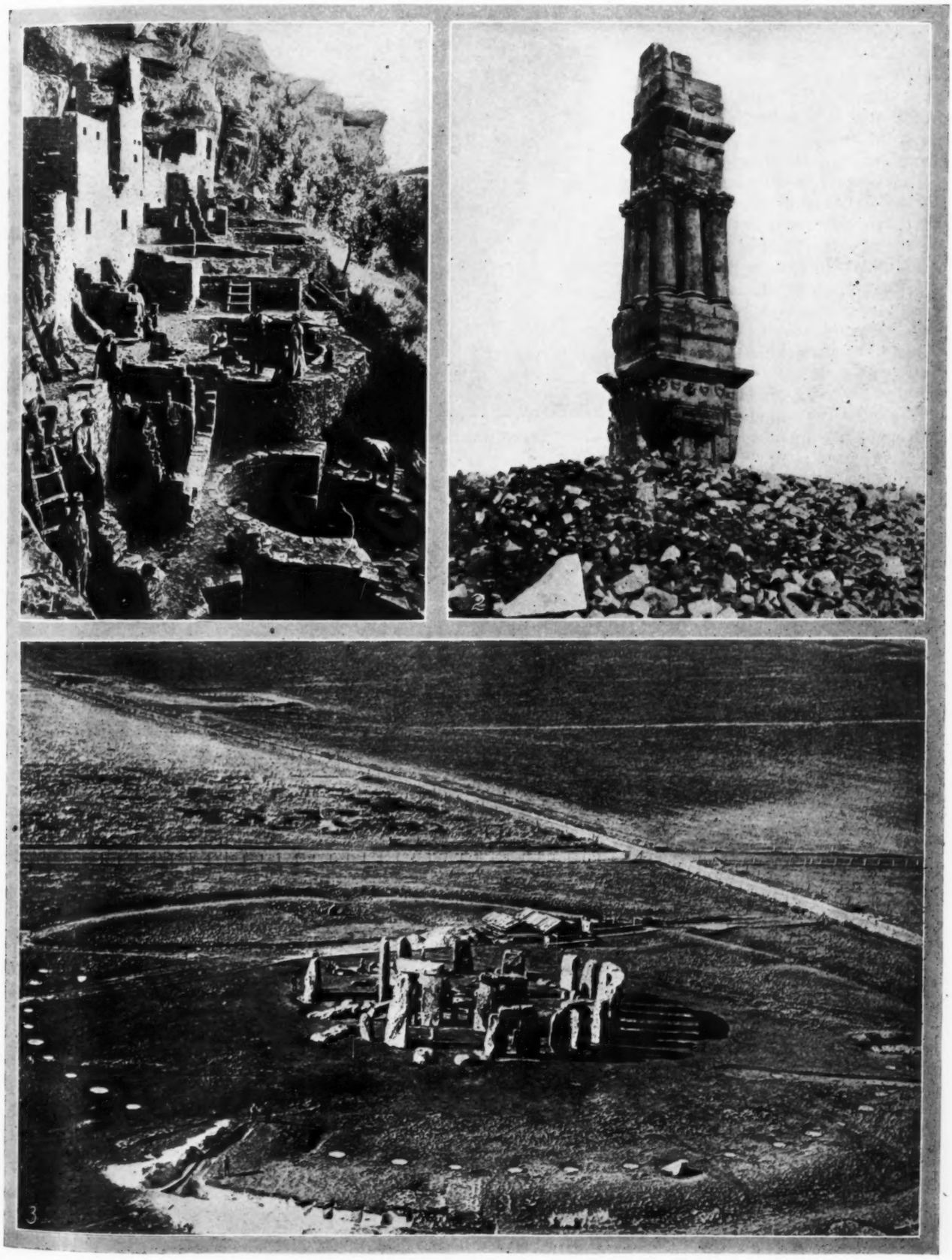
The contract for placing 6 in. compacted clay gravel surfacing was let for $49,770.00. This work was interrupted on account of the freshet, but was resumed after rebuilding the fill where the washouts occurred and was completed in due time.

Work of placing the asphalt surfacing on the bridges was started June 29, 1925, and completed July 20, 1925.

Before this project was constructed the nearest bridge to Savannah was at Augusta, a distance of 132 miles. It was necessary for tourists going south to go by way of Columbia, Augusta and Savannah and thence south to Florida. With the completion of this project the distance is shortened considerably. From Savannah to Charleston, S. C., over the new project is 128 miles, but from Savannah to Charleston by way of Augusta to Columbia is 332 miles. It will be seen that such savings in distances will be welcomed by the traveling public.

The State of Georgia and the State of South Carolina are strategically linked together, affording an outlet for the agricultural products produced by the rich soil of some of the counties in South Carolina, and a direct market to Savannah and other points.

Ancient Construction on Three Continents



1. The structures built by the cliff dwellers at Mesa Verde in Colorado, U. S. A.
2. A monument supposed to have been erected by the Roman Emperor Marcus Aurelius in Tripoli, Africa, 300 miles from the seacoast.
3. The famous Stonehenge ruins in England as seen from the air. © *International*

DENVER ADDS SIX MILES OF PIPE TO ITS WATER SYSTEM

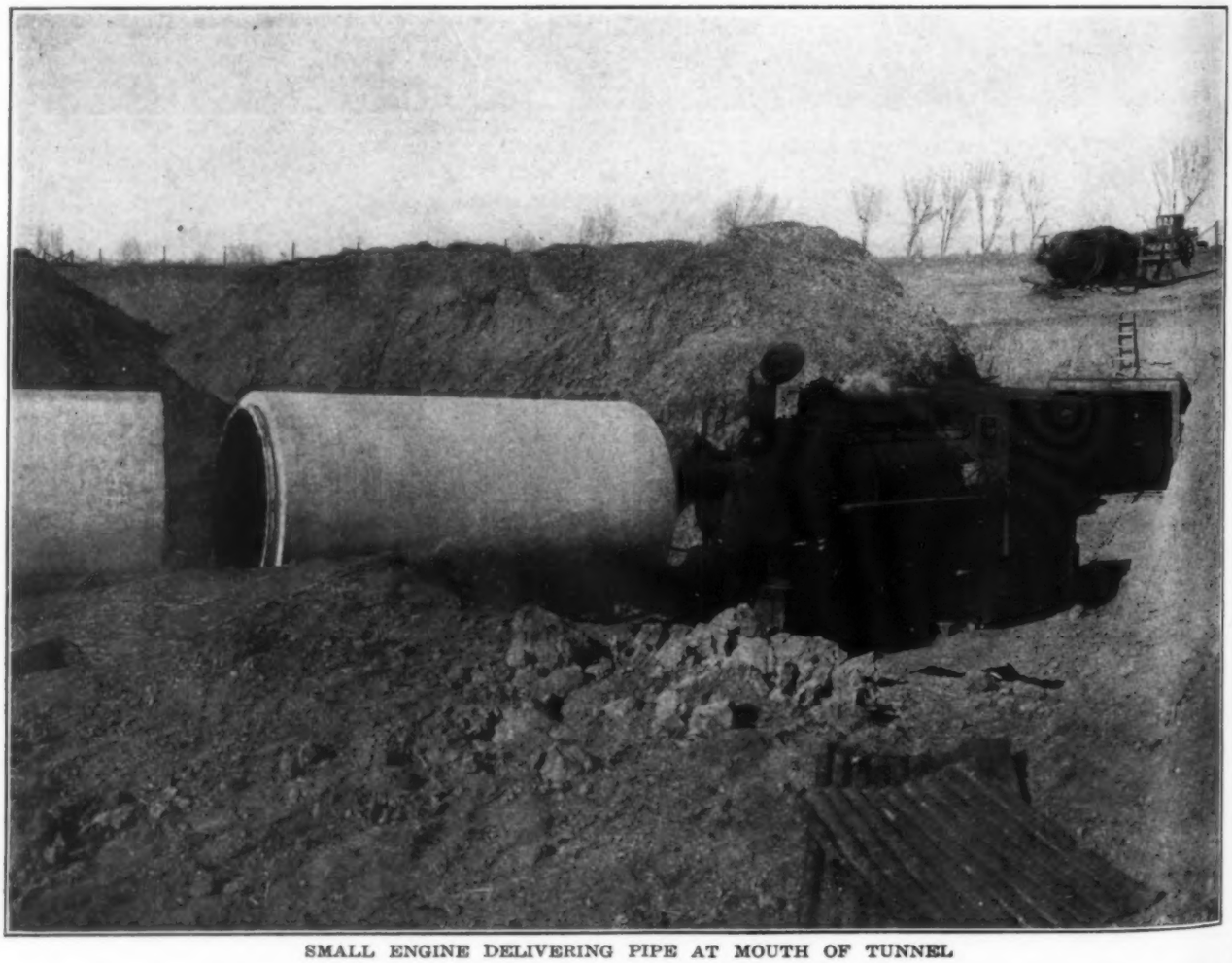
New Concrete Conduit Is Carried Through Tunnel and Over Marshy Land

BY IVAN E. HOUK

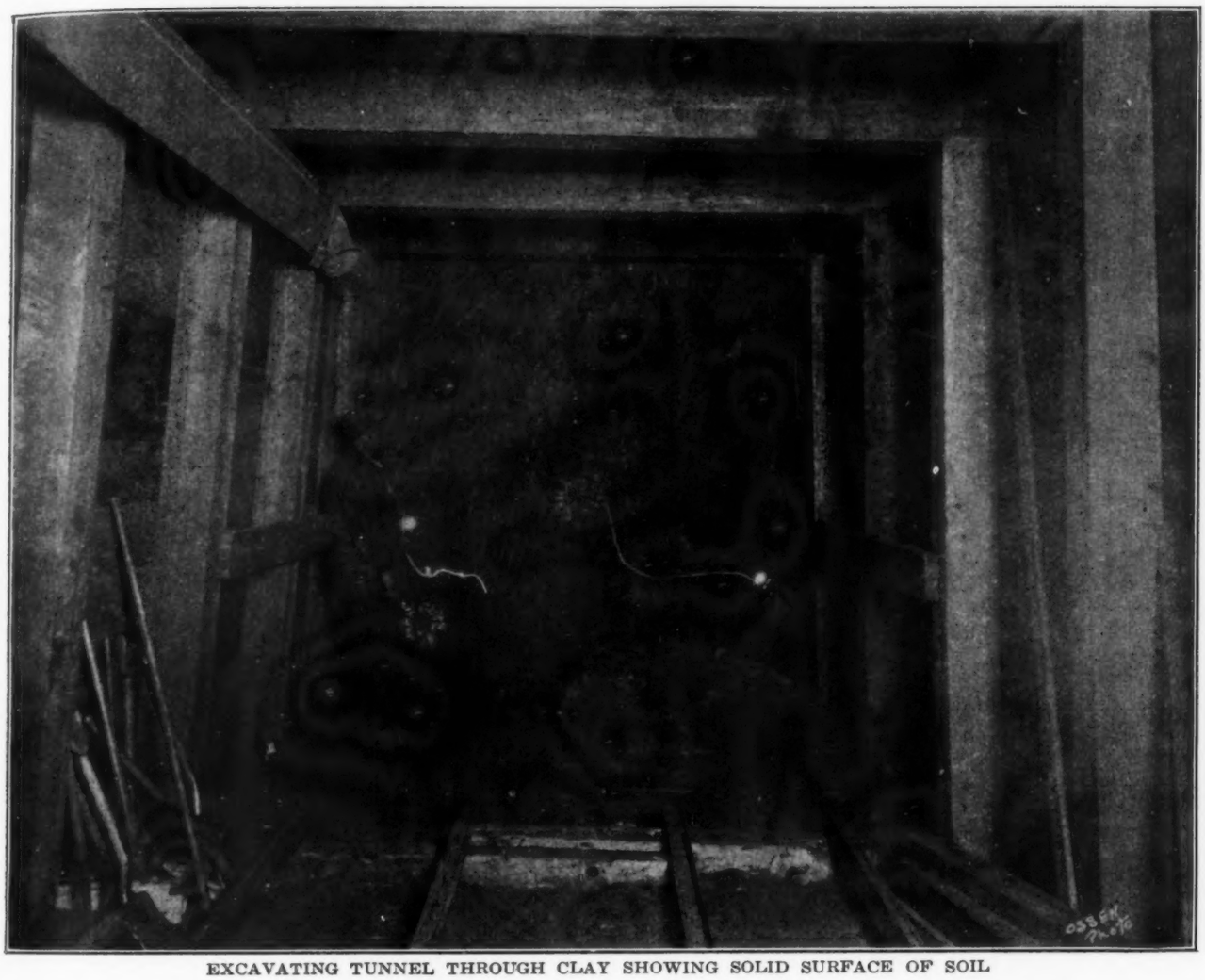
INTERESTING construction problems were involved in building Denver's new 66-in. concrete water supply conduit from the impounding reservoir known as Marston Lake to the southwestern limits of the city, a distance of slightly more than 6 miles. For instance, it was necessary to cast pipe strong enough to withstand a maximum static head of approximately 190 ft.; to lay pipe across the channel and muck-filled bottoms of Bear Creek; and to carry the line through a tunnel 575 ft. long, excavated through clay material about 30 ft. below the ground surface.

BACKFILLING TRENCH AFTER LAYING BIG PIPE

The contract was awarded to the Lock Joint Pipe Company in August, 1924. Manufacturing the pipe was started promptly and the work of laying was completed about May 1, 1925. The unit price for completed work, exclusive of 200 ft. at the Bear Creek crossing and the 575 ft. of tunnel was $26.90 a foot. This included excavation, furnishing and laying pipe and backfilling. The final total cost, including the Bear Creek crossing, tunnel work, special connections, and all extras, amounted to approximately $1,000,000.



SMALL ENGINE DELIVERING PIPE AT MOUTH OF TUNNEL



EXCAVATING TUNNEL THROUGH CLAY SHOWING SOLID SURFACE OF SOIL

The line is designed to carry 80,000,000 gal. a day. According to the specifications the leakage must not exceed 180 gal. per in. of pipe diameter, per mile, per day. While the line has not been tested at the time of writing, a similar 54-in. pipe, installed about a year ago, tested well under the specified limit. In order to avoid additional tunnel work at some future date when the growth of the city requires the construction of another conduit, 84-in. pipe were laid through the tunnel and 54-in. Y connections placed at the ends.

Four machines were used on the work, two cranes, mounted on crawlers and two trench excavators of the pull bucket type. One crane, a 25-ton machine, laid most of the pipe; sometimes, when there was sufficient open trench, laying as much as 800 or 1000 ft. a day. In fact, William B. Freeman, manager of the contractor's Denver office, says that the crane could easily keep up with the two excavators, inasmuch as the excavation was frequently delayed by running into rock, which necessitated drilling and shooting.

In the Bear Creek bottoms, where the material was a soft muck, the other crane, a 10-ton machine, drove the steel sheet piling, excavated the trench, using a clam shell bucket, and placed the 9-ton sections of pipe, completing about 400 ft. of line a week. The 25-ton crane, equipped with a large drag bucket, did most of the backfilling. About 5 men were used on each shovel crew, and about 11 men on the laying crew.

The tunnel excavation and timbering was sublet to H. R. Phillips, a local tunnel contractor, at a unit price of $35 a foot. Material was excavated by hand, and was removed in small cars, 5 men completing about 10 ft. of tunnel a day. As the section excavated was about 11 by 11 ft. in size, it was just large enough, when timbered, to pass a dinkey locomotive. Consequently the narrow-gage railroad for delivering pipe along the line beyond the tunnel was located through the tunnel rather than over the hill.

After the line was laid through the tunnel the remainder of the cross section was backfilled with concrete, without pulling the side and top timbering. The contractor chose to backfill with concrete, rather than to pull the timbers and backfill with mud, since the removal of the timbering would have been a dangerous operation. However, all floor timbers were removed.

The concrete was mixed on the ground surface, poured into the tunnel through 6-in. well casings sunk at 25-ft. spaces, and shoveled into place. This work was done in three lifts, the first lift filling the section from the floor to an elevation just below the springing line; the second lift filling the remaining space to the top of the pipe, and the third, the remaining space to the top of the tunnel.

Practically the entire line was laid on a gravel cradle. Pipe sections were cast in 12-ft. lengths, with 6½-in. walls, and were reinforced with electrically welded transverse hoops, wire mesh and longitudinal bars, about one ton of reinforcing steel being used in each length. All hoops were tested for strength of welds, up to full working pressure. Joints were designed according to standards patented by the contractor, and were calked with lead on the inside and filled with cement mortar on the outside. Mortar was also placed in the inside joints, after calking, so as to give the interior a smooth, continuous surface. About 2 ft. of backfill was placed on the pipe and allowed to settle for a time before the joints were calked. This permitted initial settlement to take place before calking.

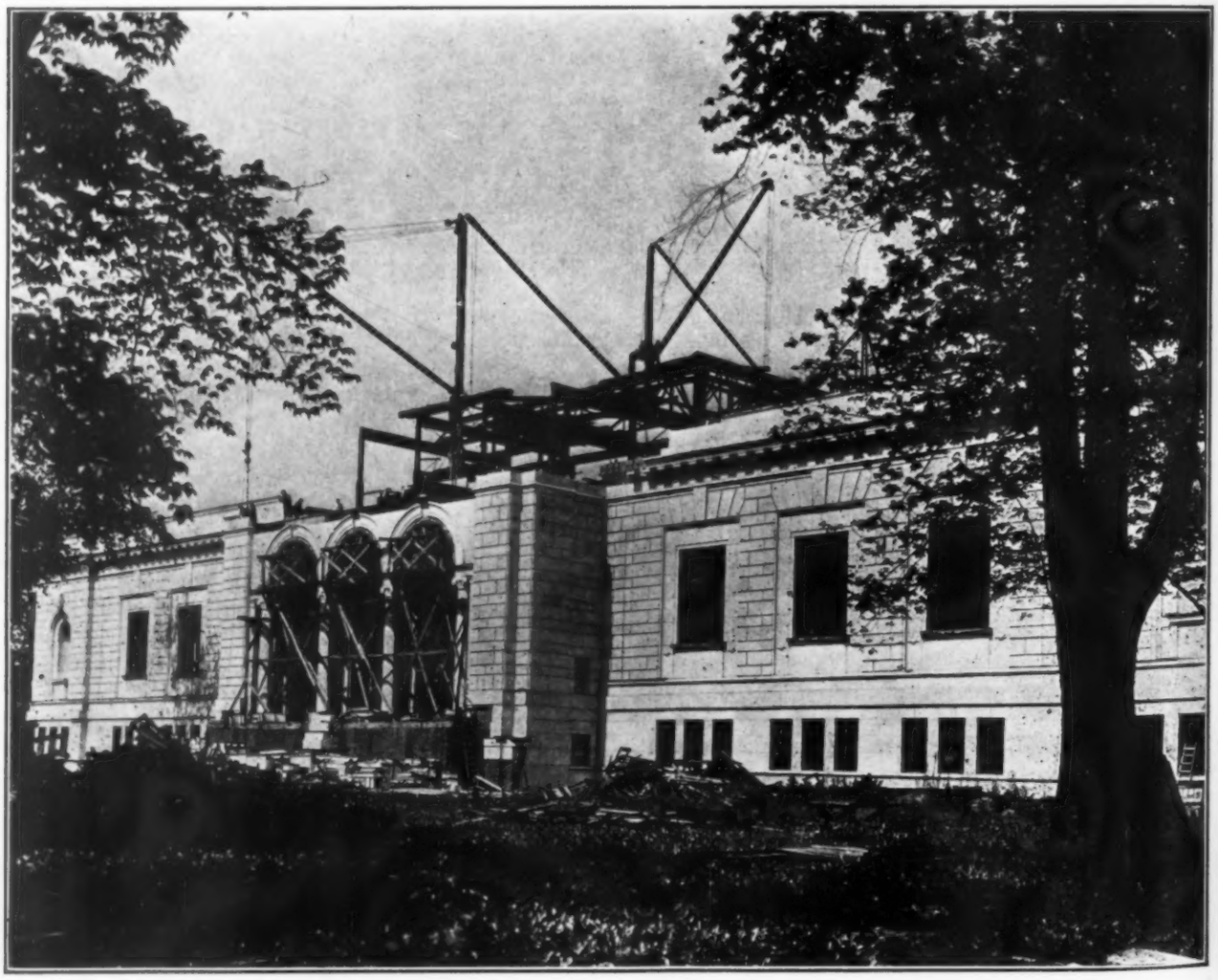
The conduit is a part of the $7,000,000 program of improvements being executed by the Denver Board of Water Commissioners under the supervision of Burton Lowther, chief engineer. D. D. Gross, office engineer, and T. J. Leahy, assistant engineer, furnished the foregoing information.

GASOLINE HOISTS SET MARBLE

SETTING matched marble is always a delicate operation, as any chipping of the stone means replacing it, and that is always an extremely difficult thing to do.

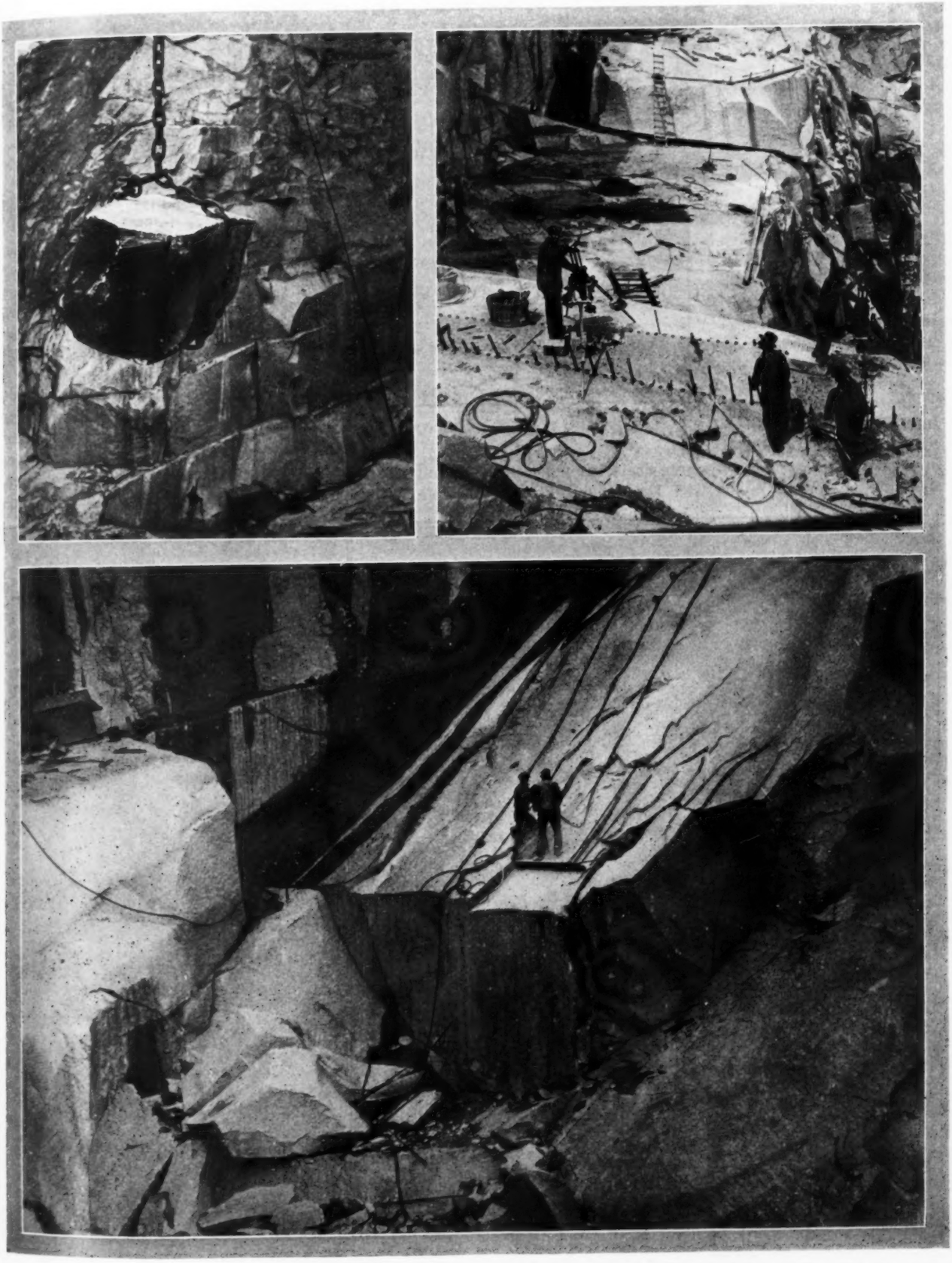
The photograph at the bottom of this page shows the new Fine Arts Building in Detroit and was taken at the time when the marble portico was under construction. All of the columns and stone were set by the two derricks shown in the photograph. These derricks were operated by two double drum gasoline hoists, one of 20 hp. and the other of 15 hp. The larger derrick was operated by the 20 hp. hoist.

The setting of the columns was one of the most difficult operations, as each column without the capital weighs 15,253 lb. When the building is completed these gasoline hoists, with the aid of the derricks, will have set 75,000 cu. ft. of marble. David F. Beveridge is the contractor.



THIS SORT OF WORK REQUIRES THE GREATEST CARE

Getting Out the Granite



The three photographs on this page show various operations in the famous granite quarries at Barre, Vt. These quarries have for years been noted for the high quality of the granite produced. © *Keystone*

A NEW VARIATION OF THE RUBBER ROAD

Old Solid Tires Are Melted and Hot Mixture Laid on Concrete Base

By G. Crowther

ABOUT a year ago illustrations were published in Successful Methods showing a rubber road surface put down in Bradford, England, which was made from blocks cut from used solid tires taken from motor vehicles. This experiment has now been supplemented by the use of rubber obtained in a similar way, but put down so as to form one piece when the work is completed.

SMOOTHING RUBBER SURFACE WITH HOT IRON

The rubber is cut up into very small fragments and then placed in a mixer near the spot where it is intended to be used. A solvent is mixed with the ground-up rubber and the rubber is taken from the mixer while still hot and carried in buckets to the prepared foundation of concrete which has been laid down.

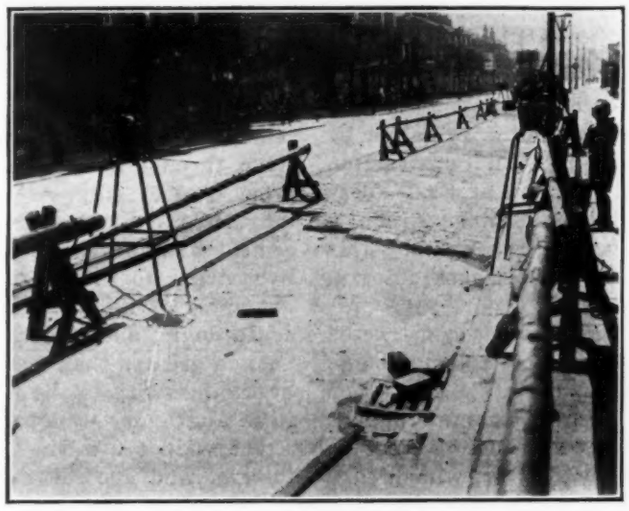
The rubber is pressed into position while still hot and laid in the form of carpet about 2½ in. thick. Wooden trowels are used, but these are coated with clay to prevent the rubber from sticking.

After the surface has set, the whole is gone over with a very hot iron of considerable weight so that the surface may be smoothed and consolidated. The accompanying photographs show the men lay-

LAYING THE RUBBER ON CONCRETE BASE

ing the rubber; the man with the heated iron smoothing and consolidating the surface; and a section in course of preparation.

Experiments in rubber pavements have been made frequently in the last few years and not all of them have met with success. For example, a rubber pavement was laid a year or two ago around the cenotaph to the Unknown Soldier in London. It did not prove serviceable, however, and a few months ago was removed.



A SECTION OF THE NEW RUBBER PAVEMENT UNDER CONSTRUCTION

In other cities in England rubber roads have been tried out and in some cases are still giving good service.

Recently a section of road was constructed in Boston, Mass. Specially prepared blocks which had been made from old automobile tires were used as it was thought that they would give greater quiet under traffic and would last longer than other forms of pavement. This pavement, of course, has not been down long enough to determine its value. An estimate of the cost of the Boston experiment gave a total of $15 a yard for the rubber pavement as compared to $6 a yard for ordinary wood blocks. It will be interesting to see how the Boston experiment works out.

DOMINICAN REPUBLIC BUILDS SPLENDID HIGHWAY SYSTEM

IN the last few years the Dominican Republic has been constructing a highway system that has accomplished remarkable results in the development of the country. The photograph below shows a typical section of one of the national highways and gives a good idea of the mountainous character of the country through which these roads have been built, and the resulting difficulties in planning and construction.

ONE OF THE THREE CONSECUTIVE CURVES ON EL NUMERO HILL

PLACING CONCRETE WITH COMPRESSED AIR GUN

A REAL test of the efficiency of the system of blowing concrete into factory walls is promised by the plant of the R. S. McManus Steel Construction Company of Buffalo, recently erected at East Ferry and Leslie Streets in that city. The plant, which is just finished, has been constructed entirely by this system of placing concrete, which makes integral slabs of the walls.

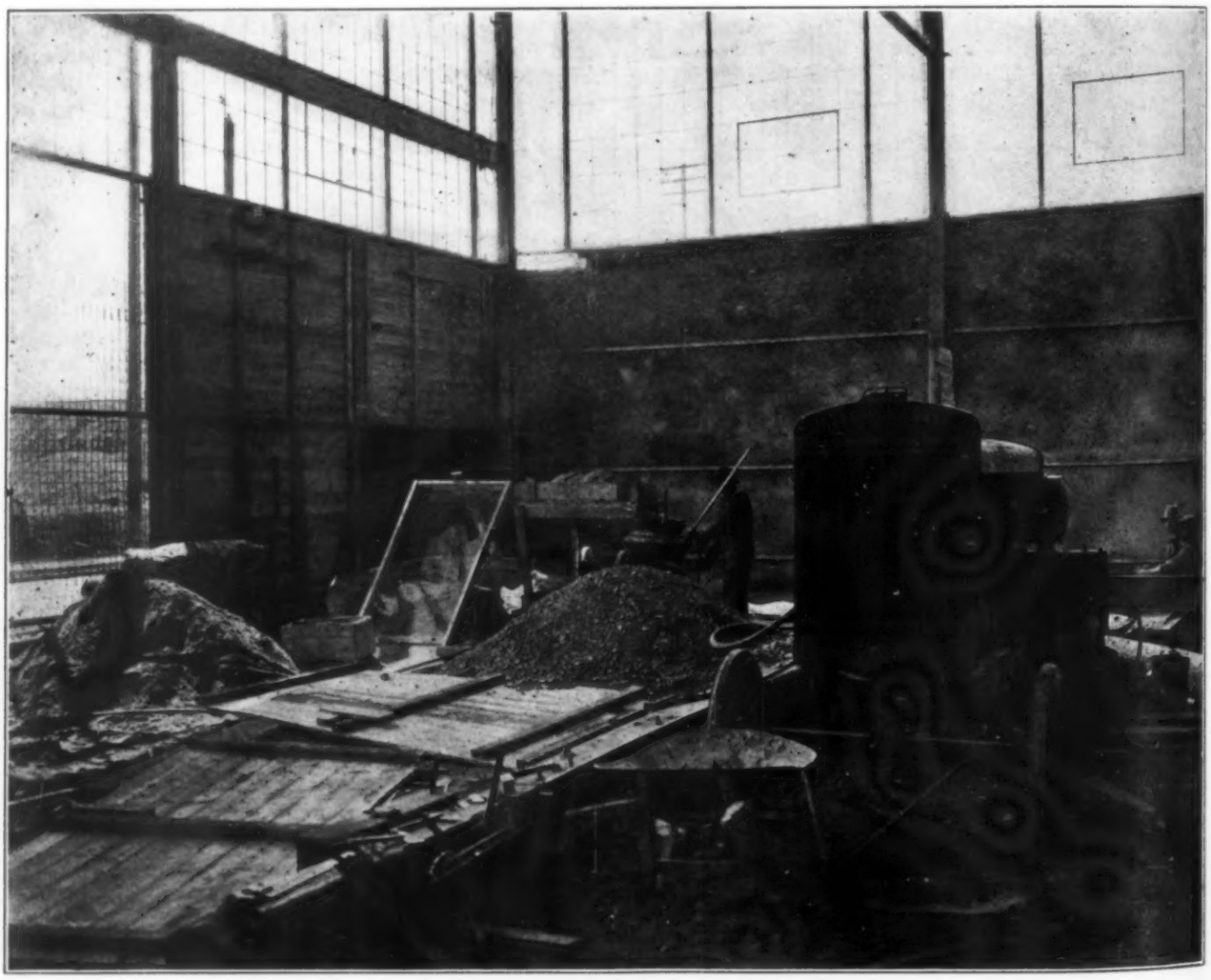
The steel frame for the building was constructed by the McManus Company, 10 in. steel columns being used. These are placed at distances of 21 ft. 6 in. on centers all around the 100 ft. by 70 ft. building, the intervening spaces being filled with concrete walls up to 18 ft., all above this being plate glass windows.

In placing this material, the reinforcing was first set and locked in position. This consists of No. 8 wire with a 4 in. mesh, the wire having a one-mesh overlap at all joints, and the joints being locked together, giving a continuous stretch of reinforcing material. A single form is used in placing the concrete, the form being set up while a workman sprays the concrete against it from a compressed air gun.

A portable 9 by 8 compressor is used to furnish power for this work. The mix, which is one part cement to three parts sand and grit, is screened three times through a ⅜ in. mesh and must test less than 2 per cent of silt. After screening, the grit passes into a continuous mixer where it is mixed with the cement and picked up by the air stream to be delivered dry to the nozzle. At the nozzle it meets a fine spray of water converging into the stream at an acute angle, and under a pressure twenty to thirty pounds greater than that used on the mix, is mixed by the pressure in the nozzle and delivered in liquid form and under pressure to the job.

The wall is 2 in. in thickness, including the reinforcing, and according to tests this thickness will withstand a pressure of 1100 lb. per sq. in. At the base of each wall is a water table and sill 14 inches high, double the thickness of the rest of the wall, and only in shooting this portion of the job were two forms used. The concrete for this portion was shot in from above into the double forms. On the rest but a single form was used.

The method gave excellent results as to speed and cheapness, the form cost being very low due to the



THE COMPRESSOR WHICH FURNISHED THE AIR

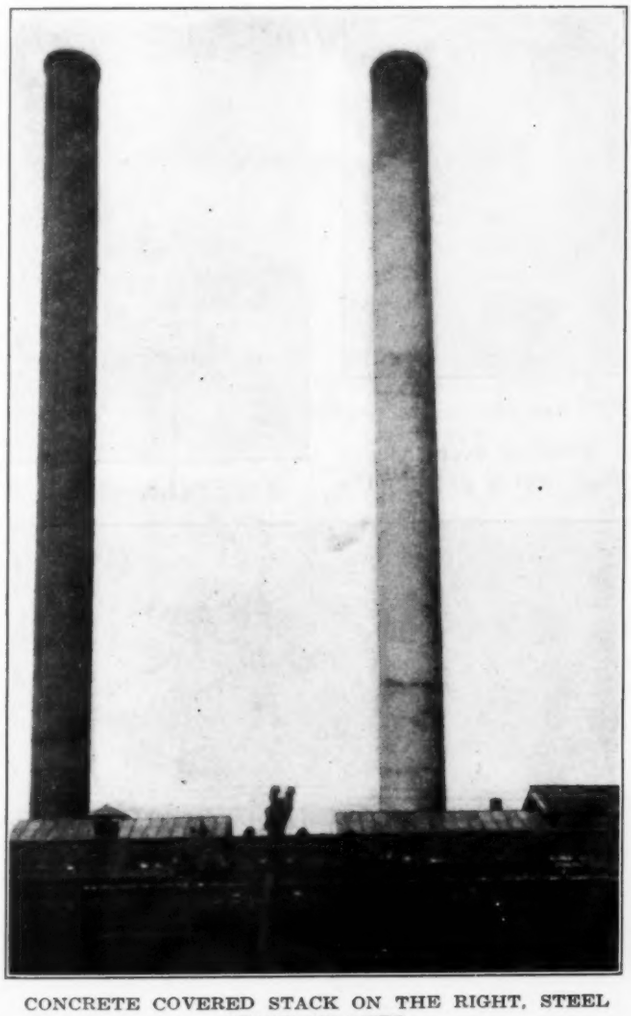
use of only one set of forms. It was found possible to remove the forms in as little as 24 hr. after the shooting of the mixture. A sill at the bottom of the sash for the windows that form the upper half of the building was shot continuous with the wall section below it, making the base for the windows one piece with the wall. The air method proved its efficiency throughout the job.

REFITTING AN OLD STEEL STACK

Concrete Sheath Is Used to Save Tall Chimney

HOW to prevent a steel stack, 180 ft. high from toppling over and at the same time keep a power station in constant operation was the difficult problem that confronted officials of the Public Service Company at Waukegan, Ill. To meet this emergency it was finally decided to construct a concrete stack, using a process originated and developed by the Cement-Gun Construction Co. of Chicago. It was stipulated in the contract that there should be no interruption whatever in the regular and continuous service of the stack while the work was under way. It was quite impossible to shut down that part of the plant.

A new reinforcing structure was designed. It was made of steel rods so arranged as to take all the stresses; in other words, the new stack would not depend on the old stack at all for its support. The new stack was securely anchored to the old foundation by means of the existing foundation bolts and these were extended by means of sleeve nuts and 1½-in. rods. A wire mesh fabric was added to this structure of rods. It was designed so as to distribute more evenly the stresses and to carry the green concrete until it had set.



CONCRETE COVERED STACK ON THE RIGHT, STEEL STACK ON LEFT

A layer of asbestos board was wrapped around the hot steel stack, inside of the reinforcing structure. This served as a compressible sheathing and prevented the contraction and expansion changes of the steel stack from being communicated directly to the outer stack.

Concrete was then shot in place. A coating was applied that was 8 in. thick at the bottom and tapered gradually to 4½ in. at the top. This mixture was 3½ parts of No. 2 torpedo sand and one part of Portland cement, shot into place with cement-guns, at a pressure of 50 lb. per sq. in., using a 14 by 12 single stage compressor driven by a 50-hp. motor. As much of the work was done in cold weather and at a time of high winds, canvas protections were needed most of the time to protect the men and machines.

SMALL LOCAL CONTRACTORS GET HIGHWAY JOBS IN MINNESOTA

MINNESOTA this year has awarded a large number of its highway contracts to contractors from the small cities and towns of the State. On a recent letting twenty contracts went to concerns from small cities, four to Minneapolis and Duluth firms, and only three to bidders from outside Minnesota.

Charles M. Babcock, state highway commissioner, points out that the local contractor is near the job, is well known in a community, employs much local labor and therefore is able to do the work economically and with a minimum of friction. He knows everybody and everybody knows him.

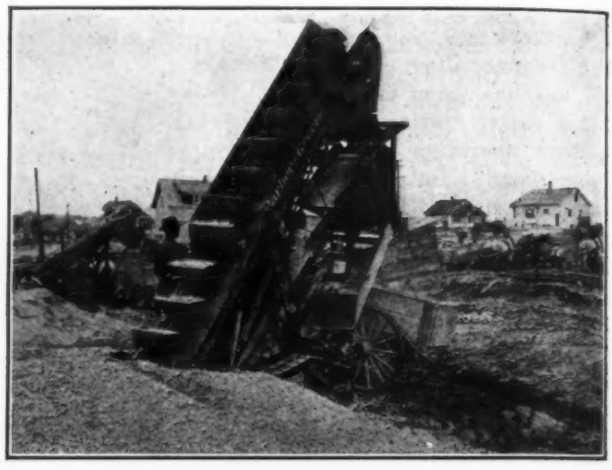
MEASURING AGGREGATES ACCURATELY

Strike-Off Hopper Automatically Controls Quantity of Stone in Each Batch

THE importance of measuring accurately the quantities of the aggregates in a batch of concrete is being more clearly recognized every day. Contractors and manufacturers alike are utilizing every means to make sure that the materials which go into the mixer are measured just as closely as possible.

The three photographs on this page show a bucket loader equipped with a strike-off hopper engaged on a city paving job in Wauwatosa, Wis. This machine is used by Jacobus & Winding of Wauwatosa, and the organization is averaging about 1000 yd. of

READY FOR LOADING



HOPPER READY TO DISCHARGE

DISCHARGE JUST BEGINNING—SURPLUS STONE RUNNING DOWN RETURN TROUGH IN STEADY STREAM

city paving a day. The bucket loader handles 16 cu. ft. of stone in every batch and averages about 250 loads a day.

The sand is being handled by a rig which requires four laborers and a home-made conveyor and Mr. Winding admits that it is by no means as efficient as the bucket loader which works beside it.

The small photograph in the left-hand column shows the strike-off hopper in position for loading. The photograph in the right-hand column shows the operator beginning to dump the hopper and it may be noted that the small stones are beginning to run down the return trough. The large photograph at the bottom of the page shows the machine just as the discharge point is reached. By that time the small stones are running down the trough in such quantity that they form a blur in the photograph.

The actual discharge of the hopper has not yet begun due to the fact that the latch on the discharge gate is not released until the strike-off is completed. In the photograph the latch is just beginning to move. The whole operation is automatic and eliminates entirely the old method of depending upon the guessing ability of the operator.

DYNAMITE EXPEDITES ERECTION OF TRANSMISSION TOWERS

Small Charges Blast Holes for Anchors in Georgia Clay

By F. J. Messick

IN putting up a high power electric line from Macon to Columbus, Ga., the Central Georgia Transmission Company of Macon has found it possible greatly to increase the speed of erecting transmission towers

AN ANCHOR SET IN CONCRETE, AND EXCAVATED TO SHOW SHAPE AND SIZE

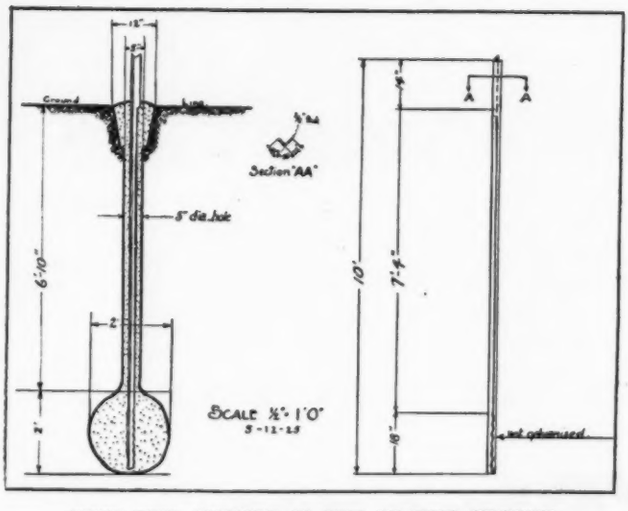
for carrying high tension cables by the use of an anchor set in concrete in a blasted hole.

The anchor consists of a 10-ft. length of angle iron corrugated for a distance of 18-in. up from the bottom in order to make it lock into the concrete. To set the anchors, holes were bored with a 5-in. dirt auger to a depth of 9 ft. and a charge of 40 per cent dynamite was exploded in the bottom of each hole with the object of making a cavity or pot hole there which would be approximately 22 in. in diameter.

The soil in this section of Georgia varies from solid red clay, or red clay over a stratum of sandstone to solid sandstone. A little experimenting showed that a charge of from 3 to 6 cartridges, depending upon the type of soil, would blast a hole of the size desired without disturbing the surface.

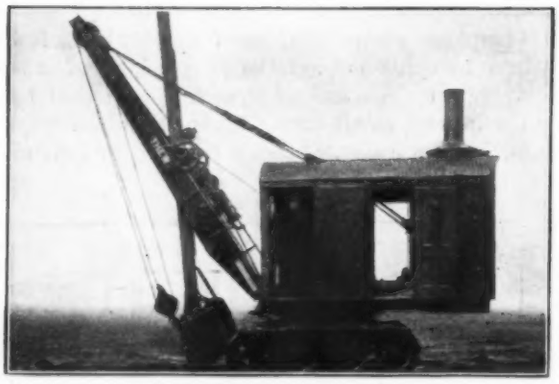
The angle irons were placed in the blasted holes and concrete was poured in to fill the holes to the mouth. After the concrete had set, the upper end of the angle iron was bolted to the tower frame, four such anchors being sunk for each tower. The makers of the anchor claim that when properly put down it will withstand a pull of 15,000 lb.

The work between Macon and Columbus required the erection of 326 transmission towers. G. L. Hadden, general superintendent for the Central Georgia Transmission Company, states that he found only a few places where he could not get the proper kind of hole for this anchor by the use of dynamite and that by blasting the holes a small crew of men can place from 16 to 20 anchors in a day, anchors, that is, for four or



HOW THE ANCHOR IS SET IN THE GROUND

five towers. This represents, of course, much faster progress than is possible with the grilled base type of anchor for which it is necessary to dig a hole by hand 9 ft. deep and 4 or 5 ft. wide.



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